FISH MANAGEMENT REPORT 110

March 1982

THE FLAMBEAU FLOWAGE FISHERY

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ABSTRACT

This investigation is the first fishery survey conducted on the 13,545-acre Flambeau Flowage and adjoining 754.3-acre Trude Lake in northern Wisconsin (considered here as one water of 14,300 acres) since the flowage's creation in 1926. Data relevant to population levels, biomass, age and growth and recruitment were gathered during 1975 for the major gamefish species. A creel census conducted during the 1975 open-water angling season and the 1975-76 ice fishing season provided data on harvest, exploitation, and recreational fishing pressure.

Walleye is the most abundant game fish and the dominant predator in the flowage; the bulk of the data addresses this species. The standing crop of walleyes was estimated at 11.6 and 13.7/acre in spring and fall, respectively. The 1975 year class was estimated at 10.1 fingerlings/acre in the fall. Biomass estimates of 10.3 and 3.8 lb/acre in spring and fall were recorded. Northern pike were present at 1.6/acre in spring and 2.5/acre in fall.

The open-water angling season exerted an estimated 14.8 hours/acre of pressure while the 3-month ice fishing season was responsible for 0.9 hours/acre. The total walleye harvest was estimated at 2.5 fish/acre or 3.0 lb/acre. The harvest rate of walleyes was 0.14 fish/hour and for northern pike, 0.11 fish/hour. Total mortality of walleyes in their third summer and older was estimated at 70% with a full-season exploitation rate of 26%. The average size of harvested walleye, northern pike, and muskellunge was 14.6 inches (1.2 lb), 17.9 inches, and 34.9 inches, respectively. Harvest rates for local and guided anglers were much higher than those for nonlocal and unguided anglers.

Migration patterns of walleyes based on the return of walleyes jaw-tagged and fin-clipped at the spawning sites were determined. Recommendations for future management based on survey results have been made.

CONTENTS

INTRODUCTION

The Flambeau Flowage located in southern Iron County in northwest Wisconsin is noted throughout the midwest for its excellent angling opportunities. Yet since its creation in 1926, no survey has been conducted to determine the status of this important fishery.

The fish population in the flowage is dominated by the walleye (Stizostedion vitreum vitreum). Other predators present include muskellunge (Esox masquinongy), northern pike (Esox lucius), largemouth bass (Micropterus salmoides), and smallmouth bass (Micropterus dolomieui). Two panfish species provide the bulk of this fishery: yellow perch (Perca flavescens) and black crappie (Pomoxis nigromaculatus). A remnant shallow-water cisco (Coregonus artedi) population is present, but adds little to the angler harvest. Other species include bluegill, pumpkinseed, rockbass, black bullhead, white sucker, shorthead redhorse, and several minnow species.

A variety of length, season, and bag limits have regulated fishing in the flowage over the years. There is now no length limit for any gamefish species except the muskellunge (30 inches). The open season for walleye, northern pike, and large and smallmouth bass runs from the first Saturday in May through 1 March, for muskellunge from the first Saturday in May through 30 November, and for all other species is continuous. The daily bag limit for walleye, large and smallmouth bass, and northern pike is 5; for muskellunge, 1; for panfish, suckers, and redhorse, 50 in aggregate; and for cisco, 25 lb and 1 fish.

During 1975 and early 1976, a comprehensive survey of the gamefish population and angler harvest was conducted on the Flambeau Flowage and connecting Trude Lake. Data concerning population levels, biomass, age and growth, and migration were gathered on the walleye and northern pike. Comparative length data were gathered for muskellunge, largemouth bass, smallmouth bass, and shallow-water cisco. An intensive creel census for all fish species was conducted during the 1975 open-water season and winter ice fishing season of 1975-76, providing insight into angler success, size preference, fishing pressure, and harvest rates.

The need for such an in-depth look at the walleye as well as other gamefish populations has become increasingly apparent. With escalating demands on the State's aquatic resources, fisheries scientists must become more informed of the nature of the resource they are charged with managing. This report is an attempt to provide some of that information.

DESCRIPTION OF STUDY AREA

The Flambeau Flowage covers an area of 13,545 acres (Fig. 1). It was created in 1926 primarily as a water reservoir and to supply hydro-electric power from its dam for a downstream paper mill located at Park Falls. Water levels continue to be maintained for these purposes and may fluctuate as much as 8-12 ft during the year, depending on anticipated runoff and precipitation. The principal inlet streams are the Turtle River and the Bear and Manitowish Rivers, which join approximately 2 miles upstream from the flowage to form the Flambeau River. The outlet stream, the North Fork of the Flambeau River, is a part of the Chippewa River drainage. The dam maintaining the flowage has a head of 27 ft and is owned by the Chippewa-Flambeau Improvement Company. Creation of the flowage flooded numerous named and unnamed lakes and streams. The basin of one of these inundated lakes (Baraboo) is the deepest part of the flowage, 50 ft.

For its size, there is a relatively small percentage of the shoreline sustaining human development. About 60-70 dwellings and 24 resorts are present. There are 5 public boat landings with parking as well as a county-owned park and camping area on the north end of the flowage. Numerous wilderness campsites on islands throughout the flowage have been provided for public use by the dam owners. There are 3.8 miles of public frontage, administered mainly by the Division of Trust Lands and Investments, and 211 total miles of mainland shoreland (Andrews and Threinen 1970).

Water quality conditions in the flowage are much the same as other lakes in the area. The water is light brown stained, with an MPA of 32 ppm, a pH of 7.1, and a specific conductance of 76 micromhos. There are 647 miles^2 of watershed area and 6,366 acres of wetlands adjoining the flowage. The irregular shoreline is reflected in the rather high SDF of 12.94. Sand and gravel are the predominant littoral bottom types with areas of muck, rubble, and boulders also present. In many areas, the littoral zone extends well away from the shoreline and numerous stump-infested flats are present. Aquatic plant growth is sparse throughout most of the flowage.

Trude Lake, connected to the flowage by several large culverts, has an area of 754.3 acres and a maximum depth of 48 ft. Water levels in Trude Lake are dependent upon the level maintained by the flowage structure. Shoreline development is minimal with approximately 10 dwellings, 1 resort, and a private camp located on the lake. As in the flowage, bottom material is predominantly sand (60%) with areas of muck, gravel, and rubble. Public access is available via navigable water access from the main flowage and an unimproved launching site with parking for 2-3 cars located near the town road crossing at the outlet. There are 6.4 miles of shoreline, all of which is in private ownership.

Water quality parameters resemble closely those of the flowage: an MPA of 29, a pH of 7.4, and a specific conductance of 73 micromhos. A watershed area of 3.7 miles^2 surrounds the lake with 215 acres of adjoining wetlands. Aquatic vegetation, both submergent and emergent, is abundant in the western one-quarter of the lake, while moderate densities are found elsewhere.

Due to the physical and chemical similarities of the two waters and their connection, harvest and population parameters presented here will be based on their total area (14,300 acres).

METHODS

Measurement of the Fishery

Population estimates for walleye and northern pike were made in spring and fall 1975 using Bailey's modification of the Petersen estimate: $N = M(C+1)/R+1$ where N = estimated population, M = number of marked individuals in the population, C = number of individuals sampled, and R = number of marked individuals in the sample (Ricker 1968, 1975).

The spring marking effort used 5 AC shocker boats for 4 nights, 4-7 May 1975, and 6 fyke nets from 30 April through 7 May 1975. The fyke nets were fished at the two major inlets, the Turtle River

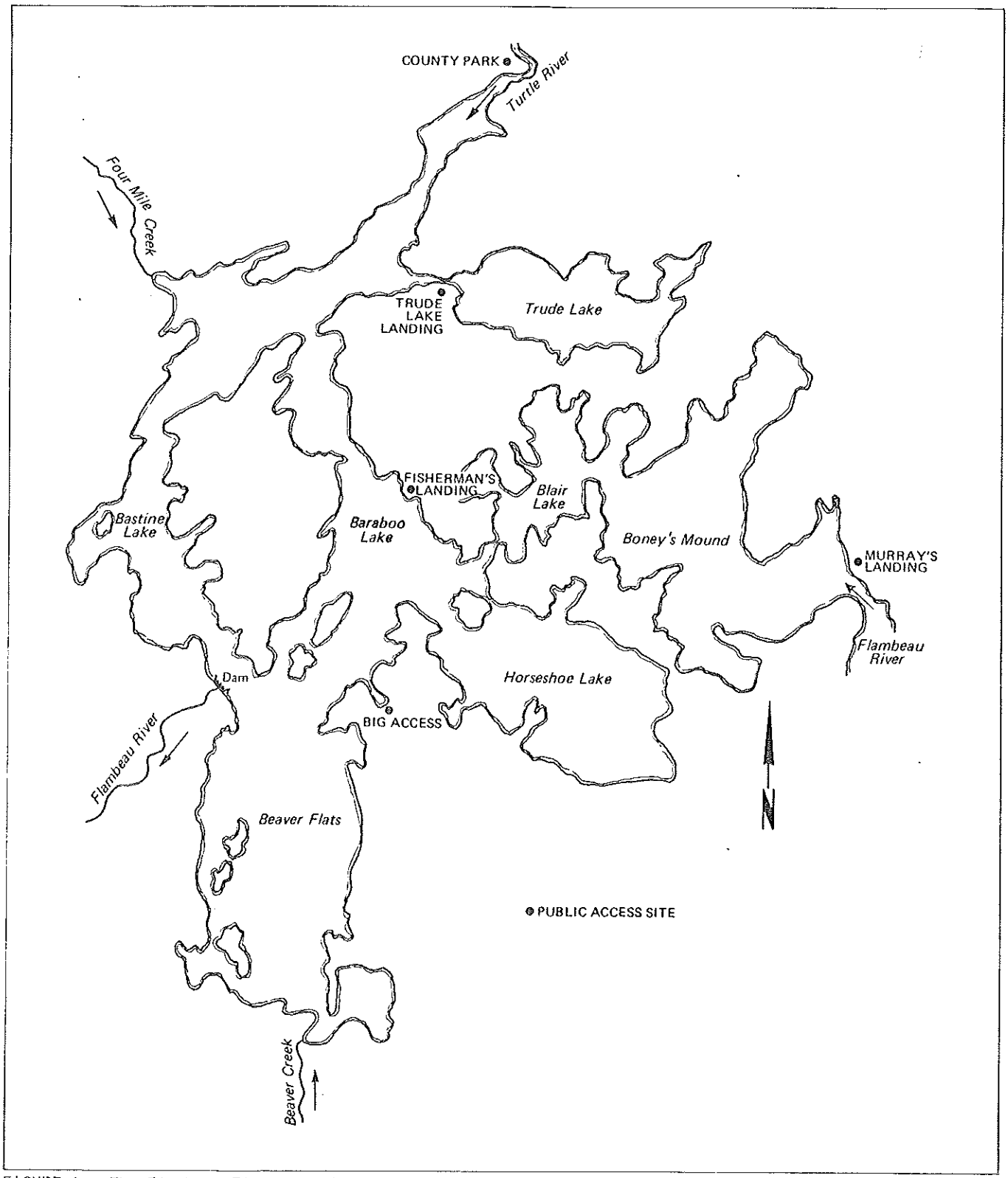

FIGURE 1. The Flambeau Flowage and Trude Lake.

and the Flambeau River, in an attempt to sample the known spawning migration of walleyes into these areas. The 2 nets at the Flambeau River inlet were removed on May 5 since the spawning run there ended several days before the run up the Turtle River.

The major walleye spawning activity in the flowage proper peaked on about 4 or 5 May, during the shocker boat portion of the sampling period. A total of 65.8 hours of shocking effort was expended.

Walleyes captured in the nets at the Turtle River inlet were given a right pelvic finclip. Walleyes 11.0 inches and larger captured in nets at the Flambeau River were given a jaw tag, while those under 11.0 inches received a left pelvic finclip. All other gamefish captured in the nets as well as all walleyes and gamefish captured with the shocker boats were given a top caudal finclip. The pelvic finclips and tags at the major spawning sites provided not only a mark for identification during

the recapture period, but also a means of discerning patterns of walleye spawning migration in the flowage and minimum harvest rates.

The recapture portion of the spring estimate employed 5 boom shockers for 4 nights, a total of 66.8 hours. Ten fyke nets were also fished for 3 days, 28-30 May 1975. The entire mainland shoreline plus that of the largest island was shocked in both the recapture and marking periods. All gamefish were marked with a bottom caudal finclip during the recapture period to avoid double counting.

Scale samples for age determination and weights were taken from 5 walleyes/half-inch group during the spring marking period. To avoid any spawning weight bias, weights were used only as a comparison to fall weights and not in computing biomass estimates. Scales were pressed on acetate slides for preservation and ease of reading.

During both the fall marking and recapture periods boom shockers only were used to collect fish. The marking period ran for 4 nights, 20-23 October 1975. It took 5 boats 63.2 hours to shock the entire flowage shoreline and that of the large island. The recapture portion of the estimate, again employing only boom shockers, ran for 67.5 hours along the shoreline.

A top caudal finclip was used to identify all gamefish during the marking period. A bottom caudal finclip was used on recaptures. About 10 walleyes/one-half inch were weighed and a scale sample was taken from each. Total lengths of all gamefish captured were recorded to the nearest one-half inch.

Estimates for 1974 and older year classes in the fall appeared low, possibly due to the relative scarcity of walleyes in these age groups along the shoreline during the fall sampling period. This has been a noted behavioral phenomenon in this species in various other surveys and adds credence to our belief that fall estimates may be biased negatively.

Estimate of Harvest

A random stratified creel census was conducted on the flowage from opening day in 1975 through the close of the ice fishing season in 1976 (3 May 1975-1 March 1976).

To determine fishing pressure, aerial counts of boats on the water and cars at the 6 access sites were made from opening day through November. Four weekdays and 4 weekend days were randomly selected each month. A single flight each census day was randomly selected from the available sunlight hours, which varied from month to month. There were 14 hours of daylight in May-July, 13 in August, 12 in September, and 10 in October. Too few fishermen were present on the flowage in November to make an estimate.

Two creel census clerks interviewed anglers at the access sites and the resorts to gather harvest data. One clerk worked the big access and Murray's Landing, while the other worked the remaining access sites and the resorts. Each clerk worked an 8-day week, extending from Wednesday to Wednesday, 10 hours each day, with 6 days off between weeks. In this manner, interviews were made every day with double coverage on Wednesdays.

The winter creel census involved angler counts by snowmobile twice each census day to determine pressure. There were two census days/week: one weekday and one weekend day. The days were systematically selected and the angler-count times were randomly chosen based on a 10-hour fishing day. Harvest data were gathered from individual anglers between angler counts each census day. This portion of the creel census started 1 December 1975 and lasted through 1 March 1976.

RESULTS

AGE AND GROWTH

Walleye

Walleyes captured in spring and fall mark and recapture periods are separated by one-inch size groups in Table 1. There were 13,560 walleyes sampled in spring and 17,620 in fall. The bulk of the walleyes sampled in spring were 11.0-17.0 inches. In fall nearly 75% were 3.0-7.9 inches, reflecting some of the size selectivity associated with sampling walleyes during these seasons.

The sex ratio of walleyes sampled in spring 1975 was 7.7:1 (Table 2). The average length and weight of walleyes of each year class is presented in Table 3. Lengths are the average of spring and fall combined while weight averages have been derived from fall data alone. Walleyes begin reaching 1 lb during their 4th summer of growth and average 1 lb during their 5th summer.

Female walleyes grow somewhat faster than males (Table 4), while male walleyes mature at an earlier age and smaller size than females (Tables 2 and 4). Males began spawning at the beginning of their 4th summer at an average length of 11.5 inches, while females began spawning at the start of their 6th summer at an average length of 14.8 inches (Table 4). Both the smallest mature male and female observed during the survey were 9.0 inches.

Northern Pike

Sizes of northern pike captured during spring and fall mark and recapture periods are presented in Table 6. There were 704 northerns captured in spring and 2,656 captured in fall. The spring sample indicates the greater relative availability of adult fish (13.0-21.0 inches) than the fall sample which shows a fairly uniform size distribution. Recruitment into the larger sizes (23 inches and over) is poor. Only 16 northern pike captured in the entire survey were over 23 inches and only 2 of these were over 27 inches long. Although age data were not obtained during this study, it appears that a fairly strong year class of northern pike was produced in 1975, evidenced by the large number of 9.0-inch and under fish captured in fall (presumably young-of-the-year). However, several mature fish of this size were sampled in spring.

Muskellunge

There were 106 muskellunge captured in spring and 77 captured in fall (Table 7). Recovery of stocked muskellunge fingerling in fall was quite good; 92 (4%) of the 2,500 stocked were recovered. Stocked fish averaged 2 inches longer (10 inches) than their natural counterparts (8.0 inches). Only one-third as many naturally produced fingerlings than stocked muskellunge were captured in the fall sampling periods, indicating the possibility of a weak 1975 natural year class.

Other Species

Smallmouth and largemouth bass represented a minimal part of the total gamefish population.

TABLE 1. Walleyes captured and marked during spring and fall sampling periods.

Length (inches)	Spring	Fall
3.0 - 3.9	13	51
4.0 - 4.9	388	2,257
5.0 - 5.9	471	7,683
6.0 - 6.9	381	3,038
7.0 - 7.9	61	432
8.0 - 8.9	315	313
9.0 - 9.9	866	594
10.0 - 10.9	576	332
11.0 - 11.9	900	270
12.0 - 12.9	1,568	415
13.0 - 13.9	1,856	470
14.0 - 14.9	1,767	478
15.0 - 15.9	1,511	410
16.0 - 16.9	1,126	321
17.0 - 17.9	789	229
18.0 - 18.9	420	148
19.0 - 19.9	242	77
20.0 - 20.9	130	38
21.0 - 21.9	72	15
22.0 - 22.9	39	16
23.0 - 23.9	23	14
24.0 - 24.9	21	7
25.0 +	25	12
Total	13,560	17,620

TABLE 2. Length frequency of male and female walleyes sampled in spring, 1975 in the Flambeau Flowage.

Length (inches)	Male	Female
9.0 - 9.9	4	1
10.0 - 10.9	56	2
11.0 - 11.9	467	1
12.0 - 12.9	1,100	2
13.0 - 13.9	1,477	11
14.0 - 14.9	1,375	64
15.0 - 15.9	1,121	161
16.0 - 16.9	801	182
17.0 - 17.9	535	153
18.0 - 18.9	267	97
19.0 - 19.9	104	97
20.0 - 20.9	38	73
21.0 - 21.9	12	41
22.0 - 22.9	4	26
23.0 - 23.9	1	16
24.0 - 24.9		15
25.0 +		18
Total	7,362	960

Sex Ratio: 7.7:1

TABLE 3. Average size of walleyes by age, for males and females combined, in the Flambeau Flowage

Completed Summers	Average Length (inches)*	Average Weight (lb)*
1	5.7	.06
2	9.0	.25
3	10.8	.41
4	12.6	.69
5	14.3	1.00
6	15.8	1.38
7	17.0	1.69
8	18.3	2.13
9	19.3	2.38
10	20.3	2.56
11	22.0	4.06
12	22.1	4.31
13	24.2	4.44

*Lengths are average of spring and fall combined; weight averages are derived from fall data only.

TABLE 4. Average size of walleyes by sex in the Flambeau Flowage, 1975.

Completed Summers	Average Length (inches) Male	Female
3	11.5	
4	12.3	
5	14.0	14.8
6	15.6	16.0
7	17.0	17.1
8	17.7	18.9
9	18.9	20.0
10	19.9	21.5
11	20.7	22.6
12	20.1	23.9
13	20.8	25.2
14	21.1	24.8
15		26.7
16		28.3

Thirty-four largemouth bass were captured ranging 3.0-6.4 inches in length. The 17 smallmouth bass captured were fairly evenly spaced from 3.0 inches to 15.4 inches.

Shallow-water cisco also maintained a viable population in the Flambeau Flowage. Most of the 71 cisco sampled were captured in fall (3-6 November 1975) and were uniformly distributed between 8.5 and 17.9 inches. The majority were adult fish apparently taken during the spawning season.

TABLE 5. A comparison of walleye growth rates in the Park Falls area.

Completed Summers	Average Length (Inches) Flambeau Flowage	10 Iron Co. Lakes	Butternut Lake (1973)	Pike-Round Lakes-1972
1	5.7	5.7	5.8	5.5
2	9.0	8.6	7.8	8.2
3	10.8	10.3	10.0	10.4
4	12.6	13.0	12.1	12.1
5	14.3	14.6	14.2	13.2
6	15.8	16.4	16.4	14.1
7	17.0	17.9	18.3	15.0
8	18.3	19.8	19.3	15.7
9	19.3	21.8	21.3	16.9
10	20.3	24.4	22.8	17.1

TABLE 6. Northern pike sampled in spring and fall, 1975, in the Flambeau Flowage.

Size (inches)	Spring	Fall
0 - 6.9	12	152
7.0 - 8.9	48	549
9.0 - 10.9	44	348
11.0 - 12.9	25	485
13.0 - 14.9	106	528
15.0 - 16.9	186	341
17.0 - 18.9	179	165
19.0 - 20.9	82	63
21.0 - 22.9	16	15
23.0 +	6	10
Total	704	2,656

POPULATION AND BIOMASS ESTIMATES

Walleye

Population estimates for walleyes in various size groups as well as 95% confidence intervals were computed for spring and fall 1975 (Table 8). The spring estimate was 165,739 walleyes and the fall estimate was 196,401, or 11.6 and 13.7 walleyes/acre, repectively, for walleyes of all sizes. This represents an overall increase of 18.5% or 30,662 walleyes from spring to fall. Only walleyes under 9 inches showed an increase in number from spring to fall due to the large number of young-of-the-year produced in 1975. Year class strength, compared in Table 9, fluctuates considerably. However, relative year class strength is maintained for up to 13 years.

Although there was an overall 18.5% increase in walleye numbers from spring to fall, there was a net loss of 113,836 walleyes or 69% when the 1975 year class, estimated at 144,498, is discounted. The percent loss by each year class ranged from 53% in the 1972 cohort to 93% for the 1964 cohort and averaged 75% for all year classes.

Biomass estimates computed for walleyes in various size groups, showed that the portion of the population below 9.0 inches gained 7,874 lb from spring to fall (Table 10). Again, this increase was due chiefly to production of the 1975 year class which added 8,670 lb to the population (Table 11). Total biomass in spring for walleyes of all sizes was estimated at 147,280 lb (10.3 lb/acre) and in fall at 54,412 lb (3.8 lb/acre). This represents an overall loss in biomass over the openwater months of 92,868 lb or 63%. Discounting the biomass of 1975 production, there was a net loss of 68.9% or 101,538 lb (7.1 lb/acre). The average loss in biomass/cohort from spring to fall was 66%, ranging from 22% for the 1972 cohort to 93% for the 1964 cohort.

Northern Pike

Estimates of standing crop in various length groups were made for northern pike in spring and fall 1975 (Table 12). Too few recaptures were sampled in spring to allow for accurate estimation in length groups. The population experienced a 57% increase, growing from 1.6/acre in spring to 2.5/acre in fall. That portion of the population under 9.0 inches was estimated at 10,024 in fall, which undoubtedly is comprised of a high percentage of young-of-the-year northern pike. Fish over 17.0 inches were estimated at 1,906 and represent only 5% of the population. This factor is also reflected later in harvest statistics.

HARVEST AND FISHING PRESSURE

Walleye

The walleye harvest (May 1975-February 1976) was estimated at 35,525 or 42,697 lb; 2.5 fish/acre and 3.0 lb/acre. The open-water season from May through October made up 94.2% of the total harvest or 33,476 walleyes (2.7 lb/acre). Winter angling (December through February) comprised the remaining 5.8% of the total with a harvest of 2,049 fish and 3,767 lb (0.3 lb/acre) (Table 13).

The major portion of the open-water harvest (nearly 60%) occurred in the 13.0- to 16.9-inch length range (Table 14). The month of May produced the largest harvest of walleyes, 16,465, nearly 50% of the total harvest. February produced the least with an estimated 413 walleyes taken (Table 15). A higher percentage of larger fish were harvested in the latter part of the open-water season than in the earlier months. This was also true for the ice fishing season, comparing December with January and February (Table 15). An average of 74.2% of the walleyes harvested during the open-water season were greater than 13 inches. This ranged from a high of 90% in October to 61% in August. The winter season had a greater portion of its harvest in larger walleyes (over 15.0 inches) than did the open-water season (60% and 40% respectively). The first month of the open-water and the ice fishing seasons produced the largest harvest during that part of the season. However, more walleyes were taken in each length category in May than in any other month.

Angling pressure was heaviest in May during the open-water season with an estimated 4.1 hours/acre and lightest in October with 0.7 hours/acre. Total open-water fishing pressure was 14.8 hours/acre from May through October. Ice fishing added only 0.9 hours/acre of fishing pressure and most of this was in the Baraboo Lake area (Fig. 1), due mostly to its accessibility.

The average size of walleyes harvested during the open-water season was 14.6 inches and 1.2 lb, with

TABLE 7. Muskellunge sampled in spring and fall, 1975, in the Flambeau Flowage.

Size (inches)	Spring	Fall	Stocked 1975 Fall
0 - 6.9	5	15	
7.0 - 8.9	4	10	6
9.0 - 10.9		2	78
11.0 - 12.9		1	8
13.0 - 14.9		1	
15.0 - 16.9	6		
17.0 - 18.9	10	2	
19.0 - 20.9	11	4	
21.0 - 22.9	21	8	
23.0 - 24.9	8	4	
25.0 - 26.9	6	4	
27.0 - 28.9	8	4	
29.0 - 30.9	7	4	
31.0 - 32.9	6	4	
33.0 - 34.9	5	1	
35.0 - 36.9	3	4	
37.0 - 49.9	6	9	
Total	106	77	92

TABLE 8. Walleye population estimates by size group in the Flambeau Flowage, 1975.

Length (inches)	Spring Estimate	95% C.L.	Fall Estimate	95% C.L.
0 - 6.9	29,716	3,714 - 55,718	144,816	129,423 - 152,954
7.0 - 8.9	4,904	2,744 - 10,700	6,968	4,853 - 12,133
9.0 - 10.9	33,083	22,767 - 68,300	10,620	6,754 - 15,679
11.0 - 12.9	23,763	16,861 - 35,255	8,150	4,771 - 11,928
13.0 - 14.9	28,096	21,966 - 41,908	12,872	8,860 - 22,150
15.0 - 16.9	24,108	16,106 - 40,533	8,626	4,786 - 11,167
17.0 - 18.9	14,090	7,971 - 36,000	2,924	1,745 - 6,400
19.0 +	7,979	3,507 - 25,842	1,425	679 - 4,524
Total	165,739		196,401	
No./acre	11.6		13.7	

monthly averages ranging from 13.8 inches in August to 15.3 inches in October (Table 14). Winter harvested walleyes were slightly larger, averaging 16.1 inches and 1.8 lb during the 3 months of census (Table 15). As total harvest declined through the winter, average size of the walleyes taken increased by over an inch.

The harvest of 35,525 walleye represents a 21% exploitation rate of the spring population for the entire fishing season (Table 17). The 1974 year class, exploited at a rate of 2% for the season was not fully vulnerable due to size preference of anglers. The exploitation rate during the open-water season of 3-summer (1973 cohort) and older walleyes was 24%. During the ice fishing season this rate was 2%, yielding a more realistic exploitation rate for harvestable walleyes of 26% for the entire angling season. Exploitation of the various year classes varied from 14% of the 1967 cohort to 43% of the 1971 cohort (walleyes in their 5th summer). Walleyes in their 4th, 5th, and 6th summers received the bulk of the angler exploitation (55%). In the open-water season, 66% of the harvested walleyes were from these cohorts and during winter, 48%. The older age groups (over 9 years) were present in the winter harvest at a much higher rate (21%) than in the open-water harvest (6%).

Return to the creel of tagged walleyes (36/413) yielded a minimum exploitation rate of 8.7%. Tag returns indicate males were harvested at a somewhat higher rate (9.2%) than were females (6.2%).

During the open-water season, monthly average harvest rates for local anglers were 2-5 times greater than those for nonlocal anglers. Harvest rates were 0.12 fish/hour for locals in July and August and 0.30 in October. Rates for nonlocals

TABLE 9. Walleye population estimates by year class in the Flambeau Flowage, 1975.

Year Class	Population Estimates Spring	Fall	Difference No.	Percent
1975		144,498		
1974	31,422	11,923	19,499	62%
1973	25,221	9,856	15,365	61%
1972	17,034	7,941	9,093	53%
1971	22,905	9,487	13,418	59%
1970	24,115	6,098	18,017	75%
1969	18,317	2,749	15,568	85%
1968	9,970	1,850	8,120	81%
1967	7,106	735	6,371	90%
1966	3,662	572	3,090	84%
1965	1,995	366	1,629	82%
1964	1,247	82	1,165	93%
1963	1,166	244 (1963+)	2,501	91%
1962+	1,579			
TOTAL	165,739	196,401	113,836	

TABLE 10. Walleye biomass estimate by size group in the Flambeau Flowage, 1975.

Size Group (Inches)	Spring Est. (lb)	Fall Est. (lb)
0 - 6.9	1,783	9,239
7.0 - 8.9	969	1,387
9.0 - 10.9	11,627	3,624
11.0 - 12.9	13,806	4,603
13.0 - 14.9	26,539	11,967
15.0 - 16.9	34,096	12,239
17.0 - 18.9	27,785	6,099
19.0 +	30,729	5,254
Total	147,280	54,412
lbs/acre	10.3	3.8

TABLE 11. Walleye biomass estimates by year class in the Flambeau Flowage, 1975.

Year Class	Spring Est. (lb)	Fall Est. (lb)	Percent Loss
1975		8,670	
1974	1,885	2,982	
1973	6,305	4,041	36
1972	6,984	5,479	22
1971	15,804	9,487	40
1970	24,115	8,414	65
1969	25,277	4,645	82
1968	16,849	3,940	77
1967	15,135	1,749	88
1966	8,716	1,464	83
1965	5,107	1,486	71
1964	5,063	353	93
1963	5,025	1,702 (1963+)	89
1962+	11,015		
Total	147,280	54,412	63

TABLE 12. Northern pike population estimates for the Flambeau Flowage, 1975.

Size Range (Inches)	Spring Estimate*	95% C.L.	Fall Estimate	95% C.L.
0 - 8.9			10,024	6,088 - 18,266
9.0 - 10.9			2,983	1,650 - 6,600
11.0 - 12.9			4,695	3,114 - 7,267
13.0 - 14.9			11,702	9,520 - 23,800
15.0 - 16.9			4,933	2,477 - 10,066
17.0+			1,906	1,122 - 4,031
Total	23,154	12,971 - 45,400	36,243	

*Insufficient numbers were recaptured to break down the estimates into the various size groups.

TABLE 13. Walleye harvest estimation for the Flambeau Flowage, 1975-76

Month	Estimated Harvest lb	Estimated Harvest No.	% of Seasonal Harvest	% of Total Harvest	Harvest Rate
May		16,465	49	46	0.28
June		3,486	10	10	0.10
July		5,225	16	15	0.13
August		5,150	15	14	0.11
September		1,607	5	5	0.10
October		1,543	5	4	0.16
Total Open-Water Season	38,930 (2.7/acre)	33,476 (2.3/acre)		94.2	0.15
December		1,044	51	3	0.19
January		592	29	2	0.10
February		413	20	1	0.13
Total Ice Fishing Season	3,767 (0.3/acre)	2,049 (0.2/acre)		5.8	0.14
Entire Season	42,697 (3.9/acre)	35,525 (2.5/acre)			0.14

TABLE 14. Length distribution of the estimated walleye harvest, open-water season, 1975, in the Flambeau Flowage.

Length Range (inches)	May %	May No.	June %	June No.	July %	July No.	August %	August No.	Sept. %	Sept. No.	October %	October No.	Total Est. Harvest %	Total Est. Harvest No.
7 - 8.9	1	2					1	51	<1	10			<1	63
9 - 10.9	2	329	4	139	5	261	3	155	5	80			3	964
11 - 12.9	19	3,128	22	767	23	1,202	36	1,854	25	402	10	154	22	7,507
13 - 14.9	34	5,598	45	1,569	33	1,724	33	1,700	26	408	33	509	34	11,508
15 - 16.9	24	3,952	22	767	27	1,411	20	1,030	31	498	38	586	25	8,244
17 - 18.9	13	2,140	4	139	9	470	6	309	8	129	16	247	10	3,434
19.0+	8	1,316	3	105	3	157	1	51	5	80	3	47	5	1,756
Total		16,465		3,486		5,225		5,150		1,607		1,543		33,476
Avg. Length Harvested (Inches)		15.0		14.2		14.4		13.8		14.8		15.3		14.6

TABLE 15. Length distribution of the walleye harvest estimates, Ice fishing season, 1975-76, in the Flambeau Flowage.

Length Range (inches)	December %	December No.	January %	January No.	February %	February No.	Total %	Total No.
9 - 10.9	1	10	2	12			1	22
11 - 12.9	20	209	17	101	4	17	16	327
13 - 14.9	23	240	21	124	25	103	23	467
15 - 16.9	24	251	17	101	28	116	23	468
17 - 18.9	16	167	19	112	25	103	18	382
19.0	16	167	24	142	18	74	19	383
Total		1,044		592		413		2,049
Avg. length Harvested		15.6		16.2		16.8		16.1

TABLE 16. Winter walleye harvest distribution from selected personal interviews on the Flambeau Flowage, 1975-76.

Length Range (inches)	December No.	December %	January No.	January %	February No.	February %	Total No.	Total %
9 - 10.9	3	1	1	2			4	1
11 - 12.9	26	11	7	17			33	10
13 - 14.9	44	19	9	21	9	21	62	19
15 - 16.9	67	29	9	21	15	35	91	28
17 - 18.9	51	22	8	19	16	37	75	23
19.0+	42	18	8	19	8	19	58	18
Total	233		42		43		322	
Avg. length (inches)	15.3		16.0		16.9		15.6	
Harvest rate	0.45		0.21		0.35		0.38	

were 0.05 and 0.06, respectively. Guided anglers experienced even greater harvest rates: 0.27 walleye/hour in August and 0.50 in October. During the open-water months, an average of 7.9% of the anglers harvested their limit (5 walleyes), ranging from a high of 13% in May and continually declining to October with only 3.9% obtaining their limit.

The combined harvest rate during both open-water and ice fishing seasons was 0.14 walleye/hour (Table 13). Walleyes were harvested at the rate of 0.15 fish/hour during the open water months, ranging from a high of 0.28 in May to 0.10 in both June and September. Harvest of walleye averaged 0.14 fish/hour during the winter season. The early parts of both segments of the fishing season experienced high harvest rates followed by a rapid decline in angler success the next month (Table 13).

The harvest rates reflect minimum rates in most cases, due to factors inherent in the computation and design of the census. Rates during the open-water season were computed using the total time for all anglers, regardless of what species they were fishing for (this could not be determined from census data). The harvest rate for May is more accurate than other months since most angler hours were spent in pursuit of walleye. However, during the remainder of the open-water season, pressure on panfish and other species played a more important role. During the winter months, this factor was diminished since most winter angling was for walleyes. Angler success, however, was quite cyclical during the ice fishing season due to the crepuscular feeding habits of walleye; the higher harvest rate occurred in the twilight hours of late afternoon. Thus angler interviews taken even a short time before this "hot" period tended to emphasize a depressed harvest rate.

The majority of the angler interviews used in computing winter harvest rates were incomplete trips. However, as an extension of the creel census, several local anglers were asked to record their harvest data for the entire winter season (Table 16). Most of these interviews involved completed trips and the resulting harvest rates were accordingly higher. Monthly harvest rates

TABLE 17. Exploitation of walleye year classes in the Flambeau Flowage, 1976-76.

Year Class	Spring Pop. Estimate	Open Water Season Est. No. Harvested	Open Water Season % of Total	Ice Fishing Season Est. No. Harvested	Ice Fishing Season % of Total	Entire Season Est. No. Harvested	Entire Season Exploit. Rate
1974	31,422	690	2	32	2	722	0.02
1973	25,221	3,898	12	160	8	4,058	0.16
1972	17,034	6,282	19	289	14	6,571	0.39
1971	22,905	9,458	28	371	18	9,829	0.43
1970	24,115	6,233	19	322	16	6,555	0.27
1969	18,317	2,975	9	201	10	3,176	0.17
1968	9,970	1,720	5	250	12	1,970	0.25
1967	7,106	854	3	141	7	1,006	0.14
1966	3,662	439	1	95	4	534	0.15
1965	1,995	281	< 1	100	5	381	0.19
1964	1,247	263	< 1	23	1	286	0.23
1963+	2,745	351	1	65	3	416	0.15
Total	165,739	33,476	100	2,049	100	35,525	0.21

were 2-3 times as great as those resulting from the creel census, and the average harvest rate of 0.38 fish/hour was nearly 3 times that found during the census (0.14 fish/hour). Although these data cannot be compared directly to other harvest statistics due to their obvious bias, they do serve to emphasize the greater effectiveness of local anglers and the inadequacy of using data from incomplete trips during the ice fishing season.

Northern Pike

Few anglers fished the Flambeau Flowage specifically for northern pike. Most of the northern pike harvest and pressure was incidental to the walleye harvest. For this reason, it is difficult to estimate these parameters for the northern pike population. Pressure and harvest data are presented only for those anglers who caught and/or kept northerns, and therefore represents maximum harvest and catch rates (Tables 18 and 19).

The harvest rate for northern pike during the entire fishing season was 0.11 fish/hour. The harvest rate was only slightly higher in the ice fishing season than in the open-water season. However, the catch rate was substantially higher in the open-water (0.27/hour) than during the ice-covered months (0.16/hour). Anglers who caught northern pike made up nearly 36% of the total number interviewed and over 40% of the total angling hours.

The average length of northern pike harvested during the open-water months was 17.9 inches (Table 18), and during the ice fishing season was 17.4 inches (Table 19). The month of May produced the highest average length of 18.8 inches. Northern pike harvested ranged from 11.2 to 33.5 inches (Table 20) for the entire season. Only 2 northerns sampled during the spring and fall population estimates exceeded 27 inches in length.

Muskellunge

Insufficient data were available to arrive at pressure and harvest estimations for muskellunge. Although there is fishing pressure for this species, it is not excessive. During the creel census, a total of 24 legal muskellunge were recorded by the clerks. Anglers spent 717.3 hours in pursuit of these fish and nearly all interviews (92%) were for completed trips. Anglers reported releasing 40 muskellunge of both legal and sublegal size. Harvested muskellunge ranged from 30.1 to 47.0 inches (Table 21) and averaged 34.9 inches. Forty-six percent of the harvest was over 34.0 inches. The average trip length from completed trip data was 5.4 hours/trip. The overall catch rate was 0.09 muskellunge/hour and the harvest rate averaged 0.03 fish/hour. The largest harvest of muskellunge, 23, occurred in October, and the lowest, 2, in August (Table 22).

Harvest data for muskellunge were recorded from many of the resorts on the flowage in 1976 and 1977 (Table 23). Several resorts specialize in muskellunge guide service and these provided the bulk of the data. Muskellunge averaged 38.4 inches and 15.1 lb in 1976 and 36.1 inches and 14.0 lb in 1977. Harvest from resorts was heaviest in the midsummer months of July and August, in contrast to the larger fall harvest in September and October from anglers using the public access sites. This may be due to the summer vacation clientele which resorts attract, thus increasing pressure as well, at that time.

Panfish

Although population and biomass estimates for any of the panfish species were not a part of this report, harvest data were gathered during the creel census (Table 24). Yellow perch was the most common panfish species in the open water harvest, followed by rock bass and black crappie. Pumpkinseed, with 7 tallied during the census, was considered an insignificant part of the open-water harvest. The ice fishing season saw only 6 perch show up in angler interviews. Panfish harvest in general through the ice was not considered a viable portion of the creel census. Maximum open-water harvest rates varied from 0.19 fish/hr for perch and crappie to 0.16 fish/hr for rock bass. Most of the panfish harvested were taken incidentally to the walleye harvest. Perch and rock bass were released at the rate of 1 for every 3 caught while only 1 black crappie of the 87 censused was

TABLE 18. Northern pike harvest in the open-water season from the Flambeau Flowage, 1975.

Month	Hours Fished*	No. Harvested*	Avg. Size	Harvest/ Hour	Catch/ Hour
May	1,340	73	18.8	0.06	0.14
June	725	98	17.8	0.14	0.27
July	1,067	143	17.6	0.13	0.30
August	1,071	148	17.4	0.14	0.38
September	818	58	18.5	0.05	0.22
October	653	68	18.5	0.10	0.28
Total	5,674	588	17.9	0.10	0.17

*Empirical data only, from anglers who caught northern pike, and not estimates of harvest or pressure.

TABLE 19. Northern pike harvest in the ice fishing season from the Flambeau Flowage, 1975-76.

Month	Hours Fished*	No. Harvested*	Avg. Length (inches)	Harvest/ Hour	Catch/ Hour
December	261	32	17.3	0.12	0.17
January	223	28	16.9	0.13	0.14
February	174	21	18.1	0.12	0.16
Total	658	81	17.4	0.12	0.16

*Empirical data only, from anglers who caught northern pike, and not estimates of harvest or pressure.

TABLE 20. Length distribution of the northern pike harvest from the Flambeau Flowage, 1975-76 season.

Length Range (inches)	Open Water Season	Ice Fishing Season
11.0 - 12.9	2	1
13.0 - 14.9	35	6
15.0 - 16.9	149	28
17.0 - 18.9	207	27
19.0 - 20.9	93	13
21.0 - 22.9	32	5
23.0+	23	1
Total	541*	81

*This total differs from that in Table 18 due to several harvested northerns whose length could not be recorded.

TABLE 21. Length distribution of muskellunge harvest, May - October 1975, from the Flambeau Flowage.

Length Range (inches)	No. Harvested	Percent Of Harvest
30.0 - 31.9	5	21
32.0 - 33.9	8	33
34.0 - 35.9	1	4
36.0 - 37.9	5	21
38.0 - 39.9	4	17
40.0 - 41.9		
42.0 - 43.9		
44.0 - 45.9		
46.0+	1	4
Total	24	100

returned. The majority of the harvest and catch for all panfish species occurred during the summer months of July, August, and September. The highest harvest and catch rates were recorded during July for all species. No crappie or rock bass were caught during October.

SPAWNING AND MIGRATION PATTERNS

In order to identify spawning walleyes netted in spring 1975 at the two major spawning sites, an individual marking system was used. Fish captured at the Turtle river inlet site were given an RV finclip and those netted at the Flambeau River inlet were given either an LV finclip or a jaw tag. Recapture data were from the spring and fall mark and recapture periods as well as from the creel census conducted during summer and winter 1975. The location of the recovery site was recorded as closely as possible for each marked walleye recovered.

Walleye migration routes followed very closely the old channels of the two major rivers inundated by the flowage (Fig. 2). There were 703 walleyes marked at the Flambeau River inlet and 58, or 8.3%, were recovered. The Turtle River inlet site had a recovery rate of 3.9% or 148 of the 3,824 marked walleyes. Recovery data indicated there may be some intermixing of the two original river walleye populations. Individuals marked at the Turtle River site were recovered in the Beaver Flats and Horseshoe Lake areas of the flowage. However, it is apparent that the major river walleye populations have for the most part remained isolated even after 50 years of flowage influence.

There was evidence that spawning occurred around some of the islands as well as along the mainland shoreline in areas providing favorable habitat. One noted example was on a peninsula in the Horseshoe Lake area. Large numbers of spawning walleyes used the rock-rubble shoreline in spring. Since very few marked walleyes from other areas were captured in this part of the flowage, it is probable that a subpopulation is isolated in the old Horseshoe Lake Basin area.

Although it appears that the greatest number of migrating walleyes travelled only a short distance (9 miles or less), a substantial number migrated as far as 12-14 miles to the spawning grounds.

TABLE 22. Muskellunge harvest data from the Flambeau Flowage, 1975.

Month	Pressure (Hours)	No. Caught	Catch Rate	No. Harvested	Harvest Rate
May	183.9	10	0.05	2	0.01
June	30.5	4	0.13		
July	85.4	9	0.11	4	0.05
August	38.3	2	0.05		
September	144.9	16	0.11	9	0.06
October	234.3	23	0.10	9	0.04
Total	717.3	64	Avg. 0.09 fish/hour or 11.1 hours/fish	24	Avg. 0.03 fish/hour or 33.3 hours/ legal fish

TABLE 23. Muskellunge harvest data from resorts on the Flambeau Flowage, 1976-77.

Month	No. Harvested 1976*	No. Harvested 1977	Avg. Length (inches) 1976*	Avg. Length (inches) 1977	Avg. Weight (lb) 1976*	Avg. Weight (lb) 1977
May		11		33.1		10.9
June	6	17	37.7	37.3	14.3	15.2
July	14	19	38.5	34.3	15.9	12.7
August	26	24	39.3	37.3	15.7	14.7
September	13	11	36.9	37.9	13.5	15.4
October	3	1	38.3	37.0	14.3	12.0
Total (avg.)	62	83	(38.4)	(36.1)	(15.1)	(14.0)

*Flam-Bow Resort only.

TABLE 24. Panfish harvest in the open-water season, Flambeau Flowage, 1975.

	Perch	Rockbass	Black Crappie
Length Range (inches)	5.8 - 15.1	5.7 - 10.0	6.1 - 14.7
Average Length (inches)	9.4	7.6	11.0
No. Harvested	428	123	86
No. Released	220	62	1
Hours Fished*	2,232.5	753.5	455.6
Harvest Rate	0.19 fish/hour	0.16 fish/hour	0.19 fish/hour
Catch Rate	0.29 fish/hour	0.25 fish/hour	0.19 fish/hour

*"Hours Fished" is a summation of the time only of anglers who caught or kept panfish.

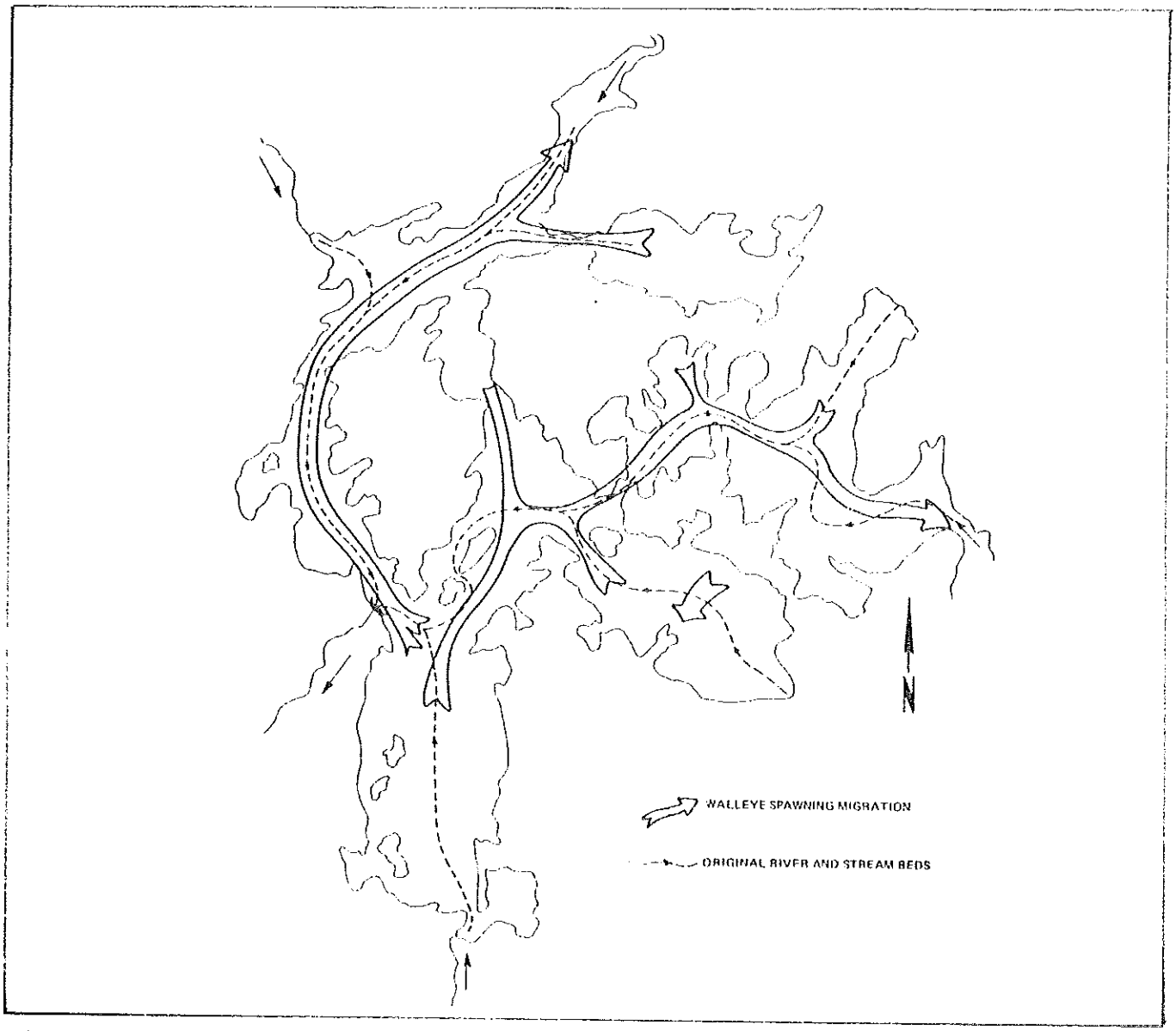

FIGURE 2. Walleye spawning migration routes.

Spawning activity up the Flambeau River began approximatly one week previous to the Turtle River and peaked 4-5 days earlier. This was due mainly to water temperature differences. Temperatures at the Flambeau River were approximately 5 F warmer than those at the Turtle River, reaching 50 F on 2 May 1975; the Turtle River was only 45 F on that date. The difference can probably be attributed to the fact that the Flambeau River inlet receives most of its drainage from the Bear and Manitowish Rivers. These rivers lose their ice earlier and as a result the water warms faster than the Turtle River, which drains directly out of a series of lakes. Spawning activity in the Horseshoe Lake area began nearly one week after it did in the Turtle River; again due to the more lentic character and resulting lower spring water temperatures.

DISCUSSION

AGE AND GROWTH

Walleye

Walleye growth rates in the Flambeau Flowage have been compared to rates in other lakes in the Park Falls area (Table 5) and in northern Wisconsin (Fig. 3). Growth was comparable to other area lakes for the first 4-5 years and then slowed somewhat in the older age groups. However, when compared to the northern Wisconsin average, the growth rate of the Flambeau Flowage walleyes was considerably slower. This is most probably due to the relative infertility of the water in this area of the state. From ages 3 through 5, flowage walleye growth was nearly one year behind the average (Fig. 3), and two years behind from ages 6 through 9.

Age at first maturity is slightly older compared to other lakes in northern Wisconsin, with males maturing at the start of their 4th year, and females at their 6th year. Several studies (Bever and Lealos 1974, 1977 and Welher and Lent, DNR, unpubl.) observed males spawning at 2-3 years and females at 3-4 years. This may be a function of the more riverine character of Flambeau Flowage walleyes as opposed to the lake-run character of other populations.

Northern Pike

Although age and growth data for northern pike were not gathered, it is apparent that recruitment into

the larger size groups in this species was quite poor. The same situation existed in most other area lakes inhabited by northern pike. Growth past 24.0 inches was rare in the Flambeau Flowage for this species, with the majority of the fishable population being in the 13.0- to 19.0-inch length category.

Muskellunge

Few muskellunge were captured during the survey in relation to their true abundance in the flowage. Voluntary muskellunge creel census charts indicated there were more legal fish taken by hook and line than were captured with survey gear. Many were caught in the Baraboo Lake area among the numerous small islands, an area not surveyed with shocker boats or fyke nets. The stocked muskellunge fingerlings captured were larger than their naturally produced counterparts and appeared in greater numbers in the survey as well. This apparent good survival of stocked fingerlings should provide the nucleus for a strong 1975 year class.

POPULATION LEVELS

Walleye

The 1975 year class of 144,498 walleyes (10.1/acre) appeared quite strong and may become a dominant part of the fishery in years to come.

Recruitment of walleyes into older age groups was excellent in the Flambeau Flowage. This is evident in both the relative strength of year classes (Table 9) and the fairly high average size of the walleye harvested. Year classes were quite strong up to age 12 in the Flambeau Flowage, while recruitment past 10 years in most lakes is uncommon. Dunst and Wirth (1972) found recruitment past 8 years to be quite poor in the Chippewa Flowage, Wisconsin.

Population estimates of 11.6 and 13.7 walleyes/acre in spring and fall, respectively, correspond well to others found in the literature (Bever and Lealos 1977, Kempinger et al. 1975, Welher and Lent, DNR, unpubl.). Several studies, however, (Bever and Lealos 1974, Dunst and Wirth 1972) have noted a much larger numerical standing crop. Walleye biomass estimates were 10.3 and 3.8 lb/acre in spring and fall, respectively. This is near the average of 6-7 lb/acre for North American lakes reported by Carlander (1955) and compares with Kempinger et al. (1975) whose Escanaba Lake, Wisconsin data ranged from 6 to 26 and averaged 17 lb/acre.

Northern Pike

Population estimates of 1.6 and 2.5 fish/acre in spring and fall, respectively, compare well with populations found in other waters of the state (Kempinger and Carline 1978). These same authors found year class production to be very sporadic in Escanaba Lake, Wisconsin and this appeared to be true for northern pike in the Flambeau Flowage. The 1975 cohort was apparently quite strong and, although pike were not aged, the 13- to 15-inch size group was exceptionally large; probably 2nd- or 3rd-summer fish. However, growth and/or survival of older cohorts was quite diminished as fall estimates found only 0.1 pike/acre over 17.0 inches.

HARVEST AND FISHING PRESSURE

Walleye

The estimated annual harvest of 2.5 walleye/acre from the Flambeau Flowage compares well with 3.6 walleye/acre found in Butternut Lake, Wisconsin (Bever and Lealos 1977). Kempinger et al. (1975) found an average harvest of 10 walleye/acre in Escanaba Lake from 1946 to 1969 and 4.6 walleye/acre were harvested from Namekagon Lake in 1976 (Welher and Lent, DNR, unpubl.). None of the above waters have length limits imposed on the walleye harvest. In Shell Lake, Wisconsin where a 13-inch size limit exists, Johannes (1978) found a harvest of 0.58 walleye/acre. Serns (1978) found that with the imposition of a 15-inch size limit on walleyes in Big Crooked Lake, Wisconsin, catch declined from 1.9/acre to 0.5/acre in a 5-year period.

The yield of walleyes in the flowage of 3.0 lb/acre (total) and 2.7 lb/acre (open-water) compares favorably with that found by Schupp (1972) of 2.0 lb/acre in Leech Lake, Minnesota. This was considered an average harvest for Minnesota walleye lakes during the open-water season. Kempinger and Carline (1977) found yields ranging from 2.7 to 23 lb/acre from 1955 to 1972 in Escanaba Lake and an average yield over this 17-year period of 8 lb/acre. Estimates of yield in the Chippewa Flowage ranged from 8.0 to 11.2 lb/acre with a 13-inch length limit and a May-November season (Dunst and Wirth 1972).

A major portion (74%) of the open-water harvest was of walleyes longer than 13 inches (a widespread past and currently controversial minimum length restriction in Wisconsin). Comparing this with other waters having liberalized length restrictions: in Namekagon Lake 90% of the harvest was above 13 inches the season following a length limit removal (Welher and Lent 1977); in Butternut Lake, Wisconsin 36% was above 13 inches 3 seasons after removal of a 13-inch length limit (Bever and Lealos 1977); and in Leech Lake, Minnesota approximately 84% of the walleye harvest was greater than 13 inches (Schupp 1972).

The average size of the walleye harvested during open water was 14.6 inches and 1.2 lb in the Flambeau Flowage and this compared very well with other waters having liberalized regulations (Kempinger et al. 1975, Schupp 1972, Welher and Lent 1977). It is also interesting to compare these data with those of lakes with 13-inch size limits. The Chippewa Flowage fishery produced an average size walleye of 1.2 lb (Dunst and Wirth 1972) and the average length of a harvested walleye from Shell Lake, Wisconsin was 14.2 inches (Johannes 1978). It is apparent from this, then, that the absence of a size limit protecting the fishery since 1958 has probably not resulted in a decrease in size of walleyes harvested by sport fishermen.

Fishing pressure on the flowage at 14.8 hours/acre (open-water season) can be considered light by national, statewide, and regional standards. Other comparable studies on walleye waters in northern Wisconsin found angling pressure to range from 8.9 to 65 hours/acre (average 34 hours/acre). Fox Lake in southern Wisconsin experienced an open-water pressure of 155 hours/acre and a total season pressure of 268.3 hours/acre in 1974 (J. Congdon, DNR, unpubl.). In the 3-year period 1965-67, Leech Lake, Minnesota averaged 7.5 hours/acre (Schupp 1972). Factors influencing the low fishing pressure on the Flambeau Flowage include its distance from major population centers, its

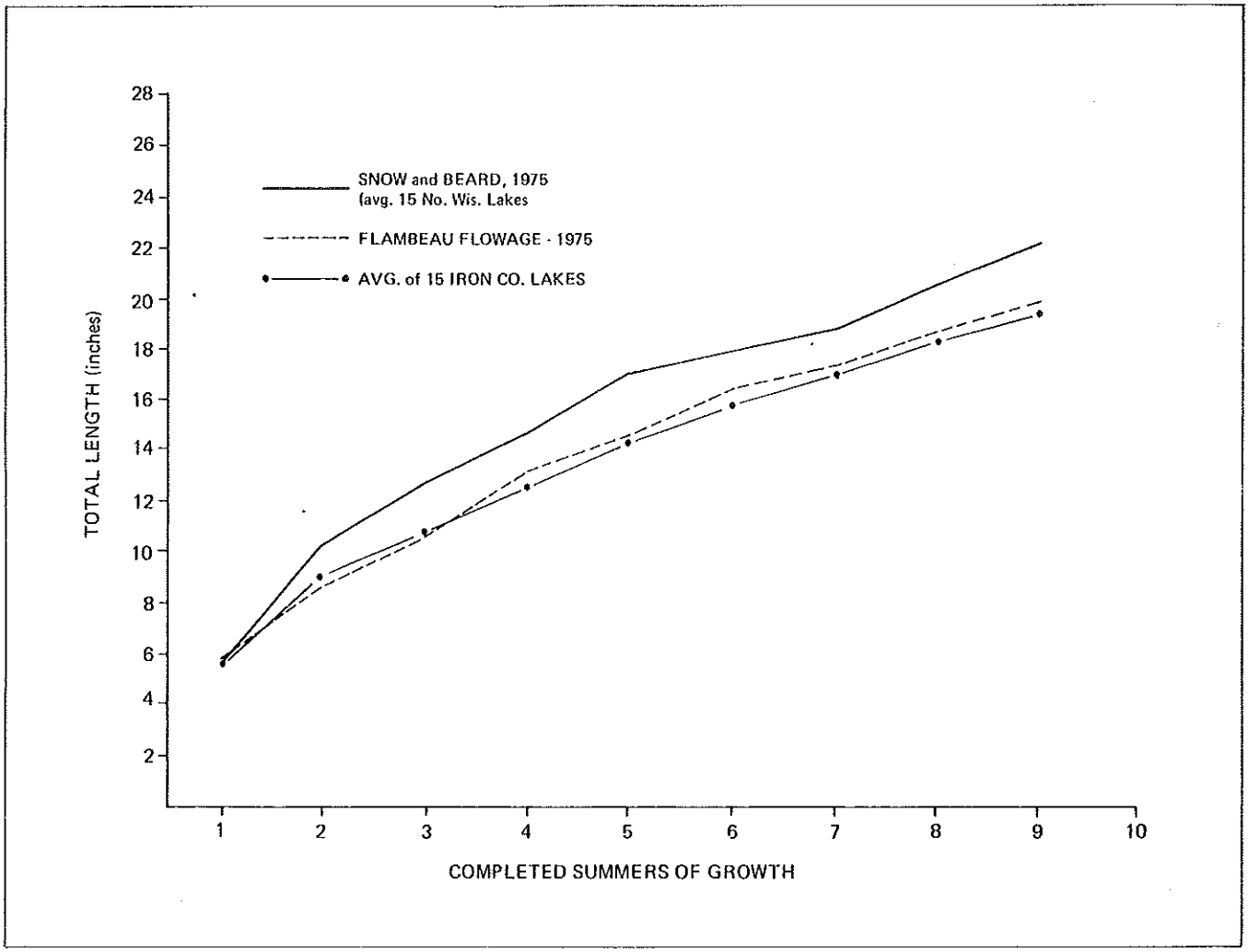

FIGURE 3. A comparison of walleye growth rates. (Snow and Beard, 1975)

unattractiveness for other water-related activities (water skiing, swimming, scuba, etc.), and the low species diversity of the fishery. This latter item probably influences pressure to the greatest degree, since angling for species other than walleye, muskellunge, and northern pike is limited in scope. The walleye is intrinsically a hard-to-catch species and thus the casual, tourist angler may become discouraged in fishing here.

The highest monthly pressure of 4.1 hours/acre (28% of the total) occurred in May, and the harvest was also highest during this first month of the fishing season: 1.2 walleye/acre (nearly 50% of the total harvest). Monthly harvest rates (Table 13) indicate a seasonal trend typical of many northern U.S. walleye waters, i.e., the early season experiences high harvest rates, followed by several months of depressed rates, and then the harvest picks up again in the last month or so of open-water angling (Schupp 1972, Forney unpubl. 1972, Bever and Leatos 1977). In his description of the Leech Lake fishery, Schupp (1972) relates this phenomenon to walleye activity patterns and the movement and abundance of forage fish, particularly yellow perch. This is suspected in the Flambeau Flowage, although yellow perch may not be as abundant in the walleye diet as they are in the Minnesota lake. Temporal location of angler-caught, tagged, and clipped walleyes, however, indicates a movement pattern opposite to that described by Schupp (Olson, Schupp, and Magins, 1978). The majority of the marked walleyes caught by anglers in both the early season (May) and late season (October) were taken near the marking site (i.e., spawning area). During mid-season the average distance fromthe tagging site was much greater. This indicates that Flambeau Flowage walleyes tend to remain near the spawning grounds in the period just after spawning, slowly migrate to other areas, and return in the fall.

Fishing pressure during the ice-covered months of December-February was extremely light (0.9 hours/acre). Few anglers, other than those seeking walleyes, were attracted to the flowage in winter. Harvest statistics also reflect these facts.

The open-water harvest rate of 0.15 walleye/hour is below the average found in the literature. However, there is a paucity of data available with which to compare winter walleye harvest rates. The 3-month ice fishing season averaged 0.14 walleye/hour with the best fishing occurring in December, just after iceup (0.19 walleye/hour). Winter harvest/acre statistics would be very misleading since fishing pressure is concentrated on several small areas of the flowage, compared to the flowage-wide pressure during the open-water season.

The exploitation rate of 0.24 during the open-water season is also comparable to that found in the

literature. Kempinger et al. (1975) noted the average rate of exploitation on several U.S. walleye lakes was 0.26. Walleyes in their 4th-6th summers made up the bulk of the harvest, and exploitation rates for these cohorts were also the highest : 0.39, 0.43, and 0.27, respectively. It is interesting to note that the 5th (1972) and 3rd (1971) most abundant year classes (of those vulnerable to angling) had the 1st and 2nd highest exploitation rates, respectively. Apparently these younger walleyes were more vulnerable to angler harvest than several of the more abundant, older year classes.

Northern Pike

Although on a per acre basis the population of northern pike in the Flambeau Flowage compares favorably with other waters, the size distribution of the population serves to discourage anglers from actively seeking this species as part of their daily bag. This factor accounts for the high catch rates and the comparatively lower monthly harvest rates (Tables 18 and 19).

There has been no size limit in effect for northern pike on the Flambeau Flowage since 1955. However, average size of harvested northerns (17.9 inches) remained far below that of other waters with this same liberal size regulation. Kempinger and Carline (1978) found an average length at harvest of 24.2 inches for northern pike taken from Escanaba Lake over a 6-year period. Snow (1978) found an average size of 21.1 inches over a 15-year period in Murphy Flowage. It appears most probable that low angler harvest and recruitment, rather than slow growth, are responsible for maintaining this situation. Other Iron County waters of similar chemical and physical character show normal to only slightly below normal growth rates and this is assumed to carry through for the Flambeau Flowage.

The maximum harvest rate of 0.11 fish/hour was considerably higher than the harvest rate of 0.027 found by Kempinger and Carline (1978). A minimum rate of 0.046 (total number of northerns harvested divided by total hours fished) appears more in line with their findings. The true harvest rate lies somewhere between these minimum and maximum values, and it is our contention that the maximum rate of 0.11 fish/hour is close to the true rate due to the relative ease with which northern pike are caught at these population levels.

MANAGEMENT IMPLICATIONS

The overall fishing pressure of 15.7 hours/acre on the Flambeau Flowage is low compared to other major walleye fisheries in the state and region. Due to reasons already stated, pressure on this body of water is expected to continue to lag somewhat behind area norms. Management of water levels by the dam owners has been fairly consistent over the years, fluctuating from full pool down to approximately 10 ft below the high water mark, the low water period coming in late winter. This water level regime has allowed successful spawning of most gamefish species and has resulted in a stable fishery. The fact that water levels do not rise and fall abruptly probably plays a key role in this success. More erratic water level fluctuations could result in more sporadic year class successes and failures.

Major spawning areas for walleye have been identified and these sites should receive continued protection from human encroachment and disturbance. Adequate year class strength has resulted from the successful use of these areas and stocking of hatchery-reared fish is not necessary.

Regulations governing angler harvest (season, length, and bag limits) have resulted in a walleye fishery comparable to many of the best in the midwest. The average walleye harvested, at 1.2 lb. under a liberal "no length limit", is equal to that of neighboring Chippewa Flowage with a 13-inch minimum length limit (since liberalized to "no length limit" in 1980). The exploitation rate of 26% is comparable, too, to other similar walleye fisheries. The season from the first Saturday in May through 1 March, however, is unnecessarily restrictive biologically. Less than 6% of the walleye harvest occurred during the ice fishing season and extension of this season to include the remaining two months (March and April) would add little to the overall harvest. The pressure that might occur would be governed by weather and ice conditions and in most years would be negligible. Late April open-water angling might be somewhat more productive depending on the timing of the walleye spawning run. However, with the present season framework, the spawning run often coincides with the season opener and spawning fish are protected by fish refuges and a concentrated law enforcement effort. Various studies in northern Wisconsin waters have shown liberal year-round fisheries to have no impact on harvest (Kempinger et al. 1975).

Should overharvest of walleyes become a concern in future years, however, the surest approach would be to delay the season opener until 1 June of each year. Since 46% of the total walleye harvest occurred during May, due to a combination of heavy pressure and vulnerability of the fish, eliminating this portion of the harvest would bring about the sharpest reduction in harvest. This may also be an easy approach to sell to the public. Many resort owners opening for the first weekend in May have little business for several weeks after that big push until June because schools are still open. Also, a sizeable segment of the fishing public opposes the availability of pre-spawn walleyes to the angler, and a later opening would eliminate that possibility. Obviously, the entire 46% would not be saved, since opening week pressure is sizeable regardless of when it occurs and some of this would carry over into June. However, an anticipated 25-40% reduction in walleye harvest could be effected with this technique, should the need arise.

The results of this and other walleye studies indicate an expected standing crop of around 10-14 walleyes/acre and fingerling production of approximately 10-20/acre in this area of Wisconsin. With this in mind, it appears that the maximum stocking rate of 50 fingerling/acre suggested in the Wisconsin DNR Fish Management Handbook is somewhat high. That figure could probably be reduced substantially to come more in line with anticipated standing crops.

Northern pike offer, in terms of size, a poor quality fishery to the angler. Protection of this species with season and bag restrictions while attempting to manage for muskellunge in the same water is unsound at best. Unsuccessful efforts have been made in the past to totally liberalize the taking of northern pike on the Flambeau Flowage. Recent changes in DNR policy, however, make it possible for the local fish manager to initiate this type of change on a lake-by-lake basis, and this should be considered here.

Water level manipulation during the muskellunge spawning season may exert a deleterious effect on

the reproductive success of this species. Extremely low water levels during spawning can isolate spawning marshes and result in sporadic natural year class strength. However, muskellunge stocking appears successful in the Flambeau Flowage and these efforts should continue. Over harvest of muskellunge is not apparent, as the average size fish harvested remains well above the state average. The flowage offers a unique, almost pristine setting to the musky angler and continued management for this species is desirable. Several large specimens are caught from its waters each year, and the possibility of a state record muskellunge living here cannot be discounted.

RECOMMENDED MANAGEMENT DIRECTION

1. Continue the present regulation framework for walleye and muskellunge.

2. Remove the bag limit on northern pike.

3. Continue stocking muskellunge fingerlings at the present rate. Monitor resort harvest figures occasionally for signs of overharvest, i.e., increased harvests, reduced size.

4. Maintain the present water level regime, avoiding massive fluctuations during spring spawning runs and rapid drops in levels during late fall-early winter.

5. Maintain walleye spawning habitat through refuges and land control.

6. Although opening week access use often exceeds capacity at nearly all sites, this is short-lived. During 99% of the fishing season, access and parking facilities are underutilized. Present access provisions are adequate.

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ACKNOWLEDGMENTS

A fisheries survey of this magnitude can only be accomplished with the cooperation of a great many individuals. We wish to thank all the fisheries personnel both in Management and Research who assisted in boom shocker operations and who donated time, equipment, and expertise from other areas of the state. Thanks are also extended to our coworkers from various other disciplines in the Park Falls area who adjusted their schedules and donated their time. We appreciate the cooperation from the resorts on the flowage for keeping track of the muskellunge harvest, in particular, Mr. Bill Tutt of Flam Bow Resort where much of the flowage's musky harvest is centered. Tom Beard, Bob Carline, Jim Kempinger, and Howard Snow contributed a great deal of the statistical background and theory in the planning and analysis. Ruth Hine and Bill Threinen provided invaluable technical criticism and editing of the final draft.